

## Claims

What is claimed is:

- 1           1.     An image processing apparatus having offset and optical black  
2     correction circuit coupled to receive a control signal having a first and second phase  
3     and an optical black signal from a charge coupled device, comprising:  
4           a.     a first circuit to sample the optical black signal at a  
5     predetermined reference voltage, the first circuit comprises  
6                 i.   a correlated double sampler,  
7                 ii. a first and second programmable gain amplifier, the first  
8     programmable gain amplifier coupled to the correlated double sampler, and  
9                 iii. an adder coupled between the first and second  
10    programmable gain amplifiers, wherein the correction circuit couples to the adder to  
11    add the positive and negative difference to the optical black signal;  
12                 iv. an analog-to-digital converter coupled to the second  
13    programmable gain amplifier for converting the sampled signal into a digital signal;  
14           b.     a second circuit to correct the optical black offset coupled to the  
15    first circuit, the second circuit comprises  
16                 i.   a reverse programmable gain amplifier coupled to the analog-  
17    to-digital converter to amplify the optical black level of the digital signal; and  
18                 ii. an integrator coupled to the reverse programmable gain  
19    amplifier to detect the optical black level of the digital signal; wherein the integrator  
20    couples to the adder.
- 1           2.     The image processing apparatus as recited in claim 1, wherein the first  
2     programmable gain amplifier comprises  
3                 a first and second sampling circuit;  
4                 a differential amplifier having a first and second input and a first and  
5     second output, the first sampling circuit coupled to the first input, the second  
6     sampling circuit coupled to the second input; and

7 a first and second feedback circuit, the first feedback circuit coupled  
8 between the first input and the first output, the second feedback circuit coupled  
9 between the second input and the second output.

1 3. The image processing apparatus as recited in claim 2, wherein the first  
2 sampling circuit comprises

3 a first and second sampling switch;  
4 a first sampling variable capacitor coupled to the first sampling switch;  
5 a second sampling capacitor coupled to the second sampling switch;  
6 a third feedback switch coupled between a power supply providing a  
7 common-mode voltage for the image processing apparatus and the first sampling  
8 variable capacitor; and

9 a fourth feedback switch coupled between a power supply providing a  
10 common-mode voltage for the image processing apparatus and the second  
11 sampling capacitor.

1 4. The image processing apparatus as recited in claim 3, wherein the first  
2 and second sampling switch closes on the first phase of the control signal and  
3 wherein the third and fourth sampling switch closes on the second phase of the  
4 control signal.

1 5. The image processing apparatus as recited in claim 3, wherein the  
2 second sampling circuit is equivalent to the first sampling circuit.

1 6. The image processing apparatus as recited in claim 2, wherein the first  
2 feedback circuit comprises:

3 a first and second feedback switch coupled to a power supply  
4 providing a common-mode voltage for the image processing apparatus;  
5 a feedback capacitor coupled between the first and second feedback  
6 switches; and

7 a third feedback switch coupled between the feedback capacitor and  
 8 the first output node of the amplifier, wherein the first output of the differential  
 9 amplifier couples to the adder.

1 7. The image processing apparatus as recited in claim 6, wherein the first  
 2 and second sampling switch closes on the first phase of the control signal, wherein  
 3 the third sampling switch closes on the second phase of the control signal.

1 8. The image processing apparatus as recited in claim 6, wherein the  
 2 second feedback circuit is equivalent to the first feedback circuit.

1 9. The image processing apparatus as recited in claim 1, wherein the first  
 2 programmable gain amplifier comprises:  
 3 a sampling circuit;  
 4 an amplifier having an input and an output, the sampling circuit  
 5 coupled to the input; and  
 6 a feedback circuit coupled between the input and the output.

1 10. The image processing apparatus as recited in claim 9, wherein the  
 2 sampling circuit comprises:  
 3 a first and second sampling switch;  
 4 a first sampling variable capacitor coupled to the first sampling switch;  
 5 a second sampling capacitor coupled to the second sampling switch;  
 6 a third feedback switch coupled between a power supply providing a  
 7 common-mode voltage for the image processing apparatus and the first sampling  
 8 variable capacitor; and  
 9 a fourth feedback switch coupled between a power supply providing a  
 10 common-mode voltage for the image processing apparatus and the second  
 11 sampling capacitor.

1           11. The image processing apparatus as recited in claim 10, wherein the  
2 first and second sampling switch closes on the first phase of the control signal and  
3 wherein the third and fourth sampling switch closes on the second phase of the  
4 control signal.

1           12. The image processing apparatus as recited in claim 9, wherein the  
2 feedback circuit comprises:

3                 a first and second feedback switch coupled to a power supply  
4 providing a common-mode voltage for the image processing apparatus;

5                 a feedback capacitor coupled between the first and second feedback  
6 switches; and

7                 a third feedback switch coupled between the feedback capacitor and  
8 the first output node of the amplifier, wherein the first output of the differential  
9 amplifier couples to the adder.

1           13. The image processing apparatus as recited in claim 12, wherein the  
2 first and second sampling switch closes on the first phase of the control signal,  
3 wherein the third sampling switch closes on the second phase of the control signal.

1           14. The image processing apparatus as recited in claim 1, wherein the  
2 second programmable gain amplifier comprises:

3                 a first and second sampling circuit;

4                 a differential amplifier having a first and second input and a first an  
5 second output, the first sampling circuit coupled to the first input, the second  
6 sampling circuit coupled to the second input; and

7                 a first and second feedback circuit, the first feedback circuit coupled  
8 between the first input and the first output, the second feedback circuit coupled  
9 between the second input and the second output.

1           15. The image processing apparatus as recited in claim 14, wherein the  
2 first sampling circuit comprises:  
3           a first sampling switch;  
4           a sampling variable capacitor coupled to the first sampling switch; and  
5           a second sampling switch coupled between the sampling variable  
6 capacitor and a power supply providing a common-mode voltage for the image  
7 processing apparatus.

1           16. The image processing apparatus as recited in claim 15, wherein the  
2 first sampling switch closes on the second phase of the control signal and the  
3 second sampling switch closes on the first phase of the control signal.

1           17. The image processing apparatus as recited in claim 14, wherein the  
2 second sampling circuit is equivalent to the first sampling circuit.

1           18. The image processing apparatus as recited in claim 14, wherein the  
2 first feedback circuit comprises:  
3           a first and second feedback switch coupled to a power supply  
4 providing a common-mode voltage for the image processing apparatus;  
5           a feedback capacitor coupled between the first and second feedback  
6 switches; and  
7           a third feedback switch coupled between the feedback capacitor and  
8 the first output node of the amplifier, wherein the first output of the differential  
9 amplifier couples to the adder.

1           19. The image processing apparatus as recited in claim 14, wherein the  
2 first and second sampling switch closes on the first phase of the control signal,  
3 wherein the third sampling switch closes on the second phase of the control signal.

1           20. The image processing apparatus as recited in claim 14, wherein the  
2 second feedback circuit is equivalent to the first feedback circuit.

1           21. The image processing apparatus as recited in claim 1, wherein the  
2 second programmable gain amplifier comprises:  
3                 a sampling circuit;  
4                 an amplifier having an input and an output, the sampling circuit  
5 coupled to the input; and  
6                 a feedback circuit coupled between the input and the output.

1           22. The image processing apparatus as recited in claim 21, wherein the  
2 sampling circuit comprises:  
3                 a sampling switch; and  
4                 a first sampling variable capacitor coupled to the first sampling switch.

1           23. The image processing apparatus as recited in claim 22, wherein the  
2 sampling switch closes on the second phase of the control signal.

1           24. The image processing apparatus as recited in claim 21, wherein the  
2 feedback circuit comprises:  
3                 a first and second feedback switch coupled to a power supply  
4 providing a common-mode voltage for the image processing apparatus;  
5                 a feedback capacitor coupled between the first and second feedback  
6 switches; and  
7                 a third feedback switch coupled between the feedback capacitor and  
8 the first output node of the amplifier, wherein the first output of the differential  
9 amplifier couples to the adder.

1           25. The image processing apparatus as recited in claim 24, wherein the  
2 first and second sampling switch closes on the first phase of the control signal,  
3 wherein the third sampling switch closes on the second phase of the control signal.

1           26. An image processing apparatus having offset and optical black  
2 correction circuit coupled to receive a control signal having a first and second phase  
3 and an optical black signal from a charge coupled device, comprising:

4               a first circuit to sample the optical black signal at a predetermined  
5 reference voltage, the first circuit comprises

6               a correlated double sampler,

7               a first and second programmable gain amplifier, the first programmable  
8 gain amplifier coupled to the correlated double sampler, and

9               an adder coupled between the first and second programmable gain  
10 amplifiers, wherein the correction circuit couples to the adder to add the positive and  
11 negative difference to the optical black signal;

12              an analog-to-digital converter coupled to the second programmable  
13 gain amplifier for converting the sampled signal into a digital signal;

14              a second circuit to correct the optical black offset coupled to the first  
15 circuit, the second circuit comprises

16              a first and second sampling circuit;

17              a differential amplifier having a first and second input and a first an  
18 second output, the first sampling circuit coupled to the first input, the second  
19 sampling circuit coupled to the second input; and

20              a first and second feedback circuit, the first feedback circuit coupled  
21 between the first input and the first output, the second feedback circuit coupled  
22 between the second input and the second output.

1           27. The image processing apparatus as recited in claim 26, wherein the  
2 first sampling circuit comprises:

3 a first and second sampling switch, the first sampling switch coupled to  
 4 a power supply providing a common-mode voltage for the image processing  
 5 apparatus, second sampling switch coupled to a predetermined optical black value;  
 6 a third and fourth sampling switch; and  
 7 a sampling variable capacitor having a first and second end, the first  
 8 and third sampling switches coupled to the first end of the sampling variable  
 9 capacitor, the second and fourth switch coupled to the second end of the sampling  
 10 variable capacitor.

1 28. The image processing apparatus as recited in claim 27, wherein the  
 2 first and fourth sampling switch closes on the first phase of the control signal,  
 3 wherein the second and third sampling switch closes on the second phase of the  
 4 control signal.

1 29. The image processing apparatus as recited in claim 26, wherein the  
 2 second sampling circuit is equivalent to the first sampling circuit.

1 30. The image processing apparatus as recited in claim 26, wherein the  
 2 first feedback circuit comprises:  
 3 a feedback capacitor.

1 31. The image processing apparatus as recited in claim 30, wherein the  
 2 second feedback circuit is equivalent to the first feedback circuit.

1 32. An image processing apparatus having offset and optical black  
 2 correction circuit coupled to receive a control signal having a first and second phase  
 3 and an optical black signal from a charge coupled device, comprising:  
 4 a first circuit to sample the optical black signal at a predetermined  
 5 reference voltage, the first circuit comprises  
 6 a correlated double sampler,

7 a first and second programmable gain amplifier, the first  
8 programmable gain amplifier coupled to the correlated double sampler, and  
9 an adder coupled between the first and second programmable  
10 gain amplifiers, wherein the correction circuit couples to the adder to add the  
11 positive and negative difference to the optical black signal;  
12 an analog-to-digital converter coupled to the second programmable  
13 gain amplifier for converting the sampled signal into a digital signal;  
14 a second circuit coupled to the first circuit to correct the optical black  
15 offset, the second circuit comprises:  
16 a sampling circuit;  
17 an amplifier having an input and an output, the sampling circuit  
18 coupled to the input; and  
19 a feedback circuit coupled between the input and the output,  
20 the feedback circuit coupled to the adder.

1 33. The image processing apparatus as recited in claim 32, wherein the  
2 sampling circuit comprises:  
3 a first and second sampling switch, the first sampling switch coupled to  
4 a power supply providing a common-mode voltage for the image processing  
5 apparatus, second sampling switch coupled to a predetermined optical black value;  
6 a third and fourth sampling switch; and  
7 a sampling variable capacitor having a first and second end, the first  
8 and third sampling switches coupled to the first end of the sampling variable  
9 capacitor, the second and fourth switch coupled to the second end of the sampling  
10 variable capacitor.

1 34. The image processing apparatus as recited in claim 33, wherein the  
2 first and fourth sampling switch closes on the first phase of the control signal,  
3 wherein the second and third sampling switch closes on the second phase of the  
4 control signal.

1           35.    The image processing apparatus as recited in claim 32, wherein the  
2   feedback circuit comprises a feedback capacitor.

1           36.    An image processing method comprising the steps of:  
2                    converting a signal of reflected light off of an object photoelectrically to  
3   obtain an optical black signal;  
4                    generating a predetermined reference voltage;  
5                    clamping the optical black signal to a predetermined reference voltage;  
6                    amplifying the optical black signal by a first gain of a first  
7   programmable gain amplifier;  
8                    amplifying the optical black signal by a second gain of a second  
9   programmable gain amplifier;  
10                   feeding back the amplified signal to a reverse programmable gain  
11   amplifier;  
12                   amplifying the optical black signal by the inverse of the second gain;  
13   and  
14                   adding the amplified optical black signal to the optical black signal after  
15   the first programmable gain amplifier.